ENUMERATION OF FALL CHUM SALMON BY SIDE-SCANNING SONAR IN THE SHEENJEK RIVER IN 1981

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Introduction

Summer and fall chum salmon represent two major stock groupings in the Yukon River. Differences between the two are based on morphological characteristics and run timing. Fall chum salmon are larger, spawn later (early September through November), and are less abundant than summer chum salmon. Fall chum salmon primarily spawn in the upper Yukon River drainage (above Tanana) in areas that are spring fed, which usually remain ice free during the winter. In contrast, summer chum salmon spawn in run-off tributaries of the Tanana, Koyukuk, and lower Yukon rivers. Fall chum salmon have comprised an increasingly important part of the total Yukon River commercial harvest in recent years.

Because of their good quality in comparison to summer chum salmon (i.e., bright, silvery appearance; large size; robust body; and high oil content), fall chum salmon are in great demand commercially and are harvested in all Yukon River fishing districts. (No commercial fishing is permitted in the Porcupine River drainage.) The majority of fall chum salmon commercial catches are presently made in the lower three districts (downstream of the village of Anvik). Fall chum salmon are of lesser importance for subsistence than summer chum salmon except in that portion of the Yukon River drainage upstream from the village of Koyukuk, where it has been estimated that they comprise 60-75% of the total subsistence harvest.

Very little information regarding the abundance and distribution of fall chum salmon was available prior to 1972. Since that time, by expanded aerial escapement surveys, the Tanana and Porcupine River systems have been identified as two of the most important in terms of fall chum salmon production. The average estimated escapement to these two systems, based on aerial assessment of selected index streams, is 73,949 and 95,371, respectively, from 1973 through 1980 (Table 1).

Prior to 1981, comprehensive enumeration studies on fall chum salmon in the Yukon River drainage, apart from aerial assessment of selected tributaries, have been limited to only two streams. Abundance, timing, and distribution information on fall chum salmon spawning populations in the Delta River (Tanana River drainage) was collected from 1973 through 1978 as a result of construction of the Trans-Alaska Pipeline (Dinneford 1978). The Canadian Fisheries Service operated a weir in the Fishing Branch River (Porcupine River drainage) from 1972 through 1975 to enumerate fall chum salmon spawning populations (Elson 1976).

Because of the need for more finite data on fall chum salmon stocks, the Sheenjek River, a tributary of the lower Porcupine River, was identified in 1975 as a potential river for installation of a counting

Table 1. Comparative Yukon River drainage fall chum aerial escapement estimates, 1973-1980.[1/]

	1973	1974	1975	1976	1977	1978	1979	1980	1973-1980 Average
TANANA RIVER DRAINAGE									
Bear Paw River	1,530	2,996	1,657	--	--	--	--	--	--
Toklat River drainage									
Upper Toklat River [2/]	6,957	34,310	42,418	35,224	25,000	35,000	107,593[3/]	23,054	
Lower Toklat River	--	--	35,867	2,000[3/]	--	--	64,540	2,140	
Subtotal Toklat R. drainage	6,957	34,310	78,285	37,224	25,000	35,000	172,133	25,194	57,762
Upper Tanana River drainage									
Benchmark #735 Slough	127[4/]	1,450	--	336	1,270	1,705	2,714	1,900[5/]	
Delta River	7,971	4,010	3,946[5/]	5,526	17,925	10,051	8,125	4,637	
Upper Tanana River[6/]	5,635	4,567	--	4,979	3,725	5,700	20,820	3,444	
Bluff Cabin Slough	3,450	4,840	5,000[3/]	3,197	6,491	5,340	6,875	3,190	
Delta Clearwater Slough (Onemile Slough)	1,720	1,235	745[3/]	1,552	1,900	475	3,850	885	
Subtotal Upper Tanana R. drainage	18,903	16,102	9,691	15,590	31,311	23,271	42,384	14,056	21,413
SUBTOTAL TANANA R. DRAINAGE	27,390	53,408	89,633	52,814	56,311	58,271	214,517	39,250	73,949
PORCUPINE RIVER DRAINAGE									
Sheenjek River	1,175	40,507	78,060	12,023	20,506	14,610	41,140	13,027	27,631
Black River drainage									
Salmon Fork River	--	444	1,517	0[4/]	--	--	--	--	
Kevenjik Creek	--	1,625	582	7[4/]	--	--	--	--[4/]	
Fishhole Creek	--	--	--	--	200[4/]	--	--	31	
Subtotal Black R. drainage	2,069	2,099	7	200				31	--
Salmon-Trout River	--	6	350	20	--	--	--	--	--
Fishing Branch River (YT)	15,987[7/]	32,525[7/]	353,282[7/]	13,450	32,500	15,000	44,080	20,319[4/]	65,892
SUBTOTAL PORCUPINE R. DRAINAGE	17,162	75,107	443,791	25,500	53,206	29,610	85,220	33,377	95,371

1/ All surveys rated fair-good unless rated otherwise. Only peak estimates listed.
2/ Includes following areas: Toklat River in vicinity of roadhouse, Shushana River, and Geiger Creek.
3/ Combined aerial and ground survey estimates.
4/ Poor or incomplete survey; very minimal and/or rough estimate.
5/ Foot survey.
6/ Richardson Highway bridge to Blue Creek.
7/ Weir count.

tower to enumerate fall chum salmon escapement and collect age-size-sex data. Specific spawning areas were located, and, due to its accessibility by aircraft or boat, this stream is considered one from which detailed stream life data on fall chum salmon can be obtained. The Sheenjek River heads in the Davidson Mountains of the eastern Brooks Range and flows approximately 250 miles to its confluence with the Porcupine River near the village of Fort Yukon.

Annual escapement estimates of fall chum salmon to the Sheenjek River have ranged from about 7% in 1973 to 54% in 1974 of the observable Porcupine River drainage escapement for the years 1973 through 1980. The average has been about 29%. Further, average escapement to the Sheenjek River has represented about 16% of the observed average fall chum salmon escapement to both the Tanana and Porcupine River systems from 1973 through 1980, based on aerial surveys of selected tributaries.

Funding was made available in 1980 to erect a counting tower and partial weir on the Sheenjek River, approximately 6 river miles upstream from its confluence with the Porcupine River, to monitor fall chum salmon escapement. The operation was unsuccessful due to abnormally high and turbid water conditions in that year. In 1981 a side-scanning sonar unit, counting tower, and partial weir were operated at the same location. This report presents results of the 1981 studies.

Objectives

Overall objectives of the 1981 Sheenjek River fall chum salmon study were to examine the feasibility of using side-scanning sonar to determine timing and magnitude of adult salmon escapements in this stream and to collect salmon age-sex-size information. The following specific objectives were identified in order to meet overall project objectives:

1. Install a single side-scanning sonar unit and partial adult salmon weir to count upstream migrants;

2. Operate a counting tower to visually count adult salmon passing the sonar substrate, as water conditions permit, to determine sonar accuracy;

3. Test fish with gillnets to examine species composition and age-sex-size characteristics of adult salmon escapement; and

4. Monitor selected climatological and hydrological parameters at the sonar site.

Methods

Adult salmon escapement to the Sheenjek River was enumerated with a side-scanning sonar counter (1981 model) developed by the Hydrodynamics Division of Bendix Corporation (Menin 1976). A single 60-ft aluminum substrate was assembled and deployed on August 30 from the west bank of the Sheenjek River (Figures 1 and 2). The substrate was deployed so that the top of the inshore transducer housing rested approximately 6-8 inches below the water surface. The offshore end was approximately 7 ft below the water surface. River water velocity caused the substrate to bow during installation and was estimated to be at least 6 ft/sec.

A salmon weir, constructed from the west bank to about 70 ft to the inshore end of the sonar substrate, helped direct upstream migrant salmon over the sonar substrate. The weir was constructed of metal "T" stakes and 1-inch by 2-inch cattle fencing. Additional sections were added to the weir when necessary due to falling river water levels.

A 20-ft prefabricated aluminum tower was erected upstream of the weir and positioned in the river near the inshore end of the sonar substrate. Three 150-watt lights were secured to the counting tower and directed over the sonar substrate to permit visual counting during hours of darkness.

Assembly and installation of the sonar substrate and counting tower and weir construction were completed by August 30, and sonar enumeration commenced at 1300 hours on August 31. The sonar counter printed hourly totals, and counts were tabulated for each 24-hour period from 0001-2400 hours. Missing sector counts (illegible, printer malfunction, or debris) were interpolated by averaging the sector counts from the hour before and after the missing sector. An assembly and operation manual for the 1981 side-scanning sonar system has been prepared by Bendix Corporation (1981).

Fish passing through the sonar beam produce a distinct oscilloscope pattern which can be distinguished from counts caused by debris. Calibration of sonar counts by the oscilloscope was made daily for the duration of the project (August 31 through September 24). Visual calibration from the tower was only possible from September 11 through September 24. Visual calibrations were desirable to assess downstream movement of adult salmon and to obtain a more precise measure of the correlation between actual fish passage and the sonar count.

A single 5-7/8"-mesh gillnet, 50 ft long by 12 ft deep, was fished in the vicinity of the sonar site to capture adult salmon for age-sex-size sampling. After exploratory fishing, it was determined that two drift locations would be fished daily. Both locations were downstream from the sonar site and permitted a cross section of the river to be sampled.

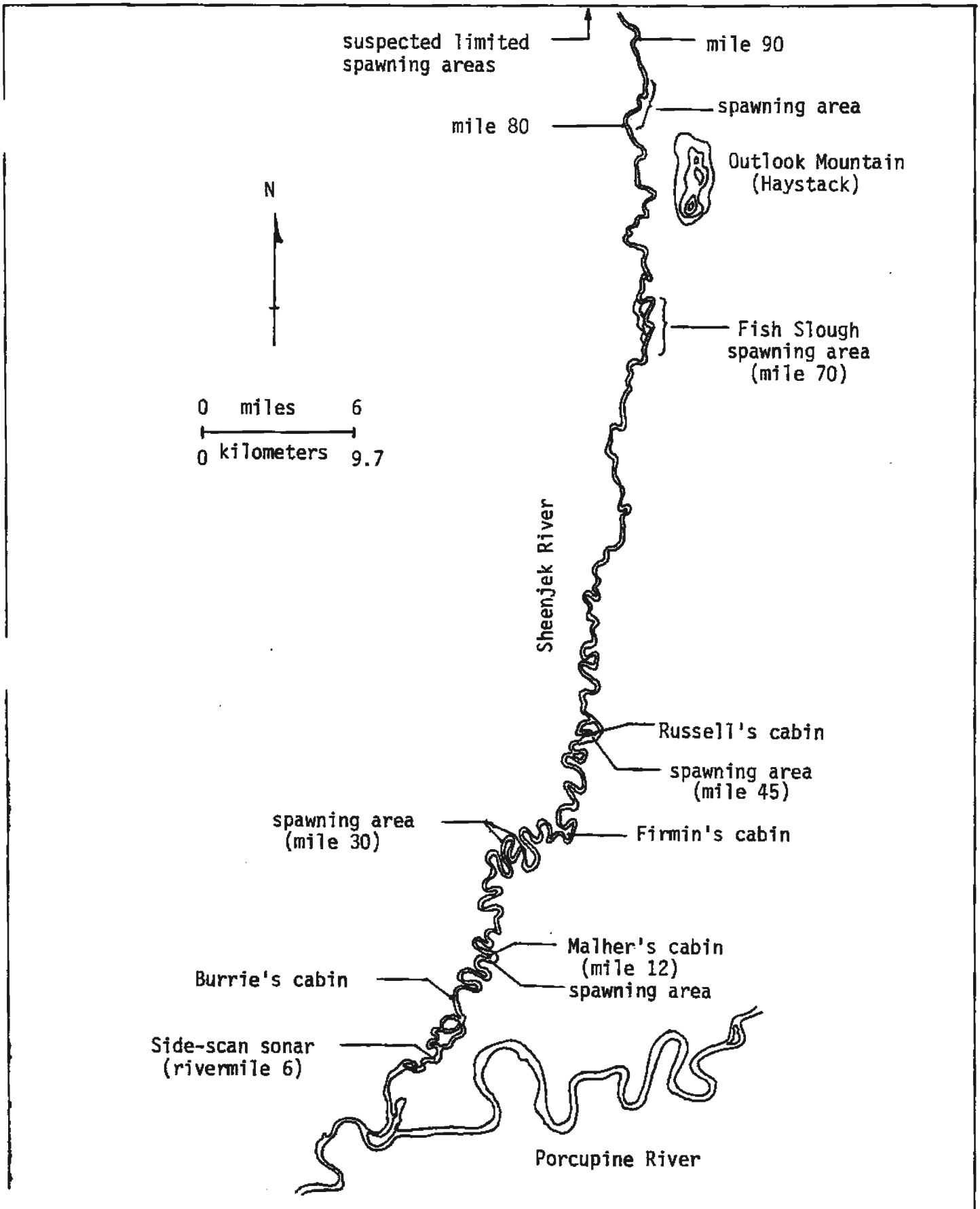

Figure 1. Sheenjek River important fall chum salmon spawning areas, 1981.

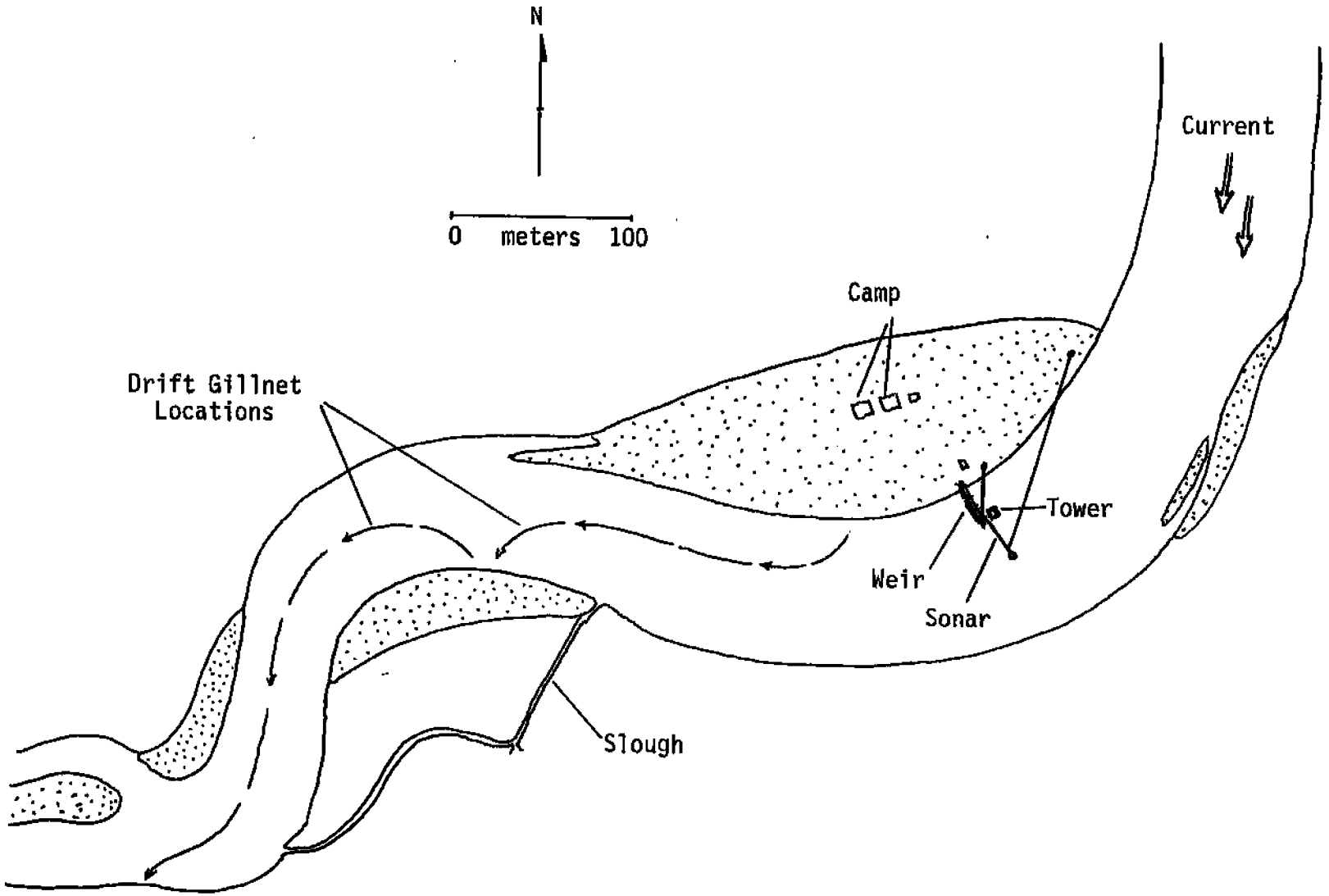

Figure 2. Sheenjek River field study site approximately 6 river miles upstream from its confluence with the Porcupine River, September 1981.

Thirty adult chum salmon were sampled daily for age-sex-size data. Each fish was sexed by external examination, measured to the nearest 5 mm from mid-eye to fork of tail, scale sampled for subsequent age analysis, and the adipose fin clipped. Duration of each gillnet drift, resulting catch, and age-sex-size data were recorded.

A river water-level gauge (meter stick) was installed at the sonar site on August 30. Daily changes in water level and water temperature were monitored at noon. Other daily observations included recording the occurrence of precipitation and percent cloud cover.

Aerial surveys of the Sheenjek River were flown on September 10 and October 2 to enumerate chum salmon escapement and determine salmon spawning distribution within the river.

Results and Discussion

Timing: A total of 489 chum salmon was counted from 1300 hours (when the sonar first became operational) through midnight on August 31, indicating that salmon were already present in the Sheenjek River prior to sonar operations (Table 2). A local trapper stated that chum salmon had been present in the river in low numbers for about 2 weeks prior to sonar installation.

Sonar counts increased rapidly during the first week of September, reaching a peak on the 7th, when 8,714 fish were counted. This peak count represents a daily percent passage of 12.4. By comparison, the highest CPUE from gillnet test-fishing occurred on September 6 (Figure 3). Sonar counts decreased sharply from the 7th to the 10th, and by September 11 nearly 80% of the run from August 31 through September 24 had been counted. Chum salmon continued to pass the sonar site daily from September 12 through the 24th, with a relatively gradual decrease in numbers. It is suspected that an unknown number of chum salmon passed the sonar site after its removal on September 24 since almost 600 were observed below the sonar site on the October 2 aerial survey.

River water temperatures at the sonar site ranged from 48.2°F on August 31 to 37.4°F on September 24, with an average of 41.9°F for the duration of the project (Figure 4). Water temperature remained at 41.0°F from September the 3 through 9, the period of peak passage.

Hourly migration of chum salmon by the sonar site cannot be precisely evaluated due to problems encountered with adult salmon milling over the sonar substrate. However, general observations revealed a distinct diurnal migration pattern. In general, chum salmon were observed holding or resting in shallow water along gravel bars and slough areas during daylight hours. Upstream migration commenced with the onset of darkness and continued through hours of suppressed light, decreasing

Table 2. Sheenjek River daily and cumulati[illegible]l chum salmon sonar counts from August 31 throu[illegible] September 24, 1981.[1/]

Date	Actual Sonar Count	Percent Calibration Agreement Oscilloscope	Percent Calibration Agreement Visual	Percent Downstream Movement	Adjusted[2/] Sonar Count	Percent Daily	Percent Cumulative
8/31	489	--			489	0.7	0.7
9/1	1,893	--			1,893	2.7	3.4
9/2	2,443	91.5			2,235	3.2	6.6
9/3	5,303	108.4			5,748	8.2	14.8
9/4	5,930	104.1			6,173	8.8	23.6
9/5	9,955	65.6			6,530	9.3	32.9
9/6	9,889	69.0			6,823	9.7	42.6
9/7	9,566	91.1			8,714	12.4	55.0
9/8	10,840	74.8			8,108	11.6	66.6
9/9	6,154	79.3			4,880	7.0	73.6
9/10	3,745	60.4			2,261	3.2	76.8
	Σ 66,207	81.3			Σ 53,854[3/]	76.8	76.8
9/11	3,657	54.4	47.0		1,718	2.5	79.3
9/12	3,232	47.5	37.3		1,205	1.7	81.0
9/13	3,288	60.6	55.7		1,831	2.6	83.6
9/14	2,079	64.9	77.5		1,611	2.3	85.9
9/15	1,517	102.6	107.1		1,624	2.3	88.2
9/16	2,039	77.2	73.7		1,502	2.1	90.3
9/17	1,075	89.4	86.2		926	1.3	91.6
9/18	1,911	88.2	100.0		1,911	2.7	94.3
9/19	1,093	70.0	77.0	21.5	660	0.9	95.2
9/20	1,360	80.8	75.1	26.5	750	1.1	96.3
9/21	960	95.4	84.6	9.0	738	1.1	97.4
9/22	964	80.1	81.8	18.5	642	1.0	98.4
9/23	1,036	82.3	85.7	23.8	675	1.0	99.4
9/24	521	--	--	19.8	417	0.6	100.0
	Σ 24,732	71.0	69.5	21.6	Σ 16,210	23.2	100.0
Grand Total	90,939	--	--	--	69,043[4/]	100.0	100.0

1/ Sonar was operational from 1300 hours August 31 through 1300 hours September 24.

2/ Adjusted sonar counts from August 31 through September 10 are based on oscilloscope calibrations; adjusted counts from September 11 through 18 are based on visual calibrations; and adjusted counts from September 19 through 24 are based on visual calibrations and percent downstream movement observations.

3/ This figure was further adjusted downward by 1.5% to 52,833 based on observations of differences between visual (tower) and oscilloscope calibrations from September 11-24.

4/ The final sonar estimate (69,043) was the sum of 52,833 and 16,210.

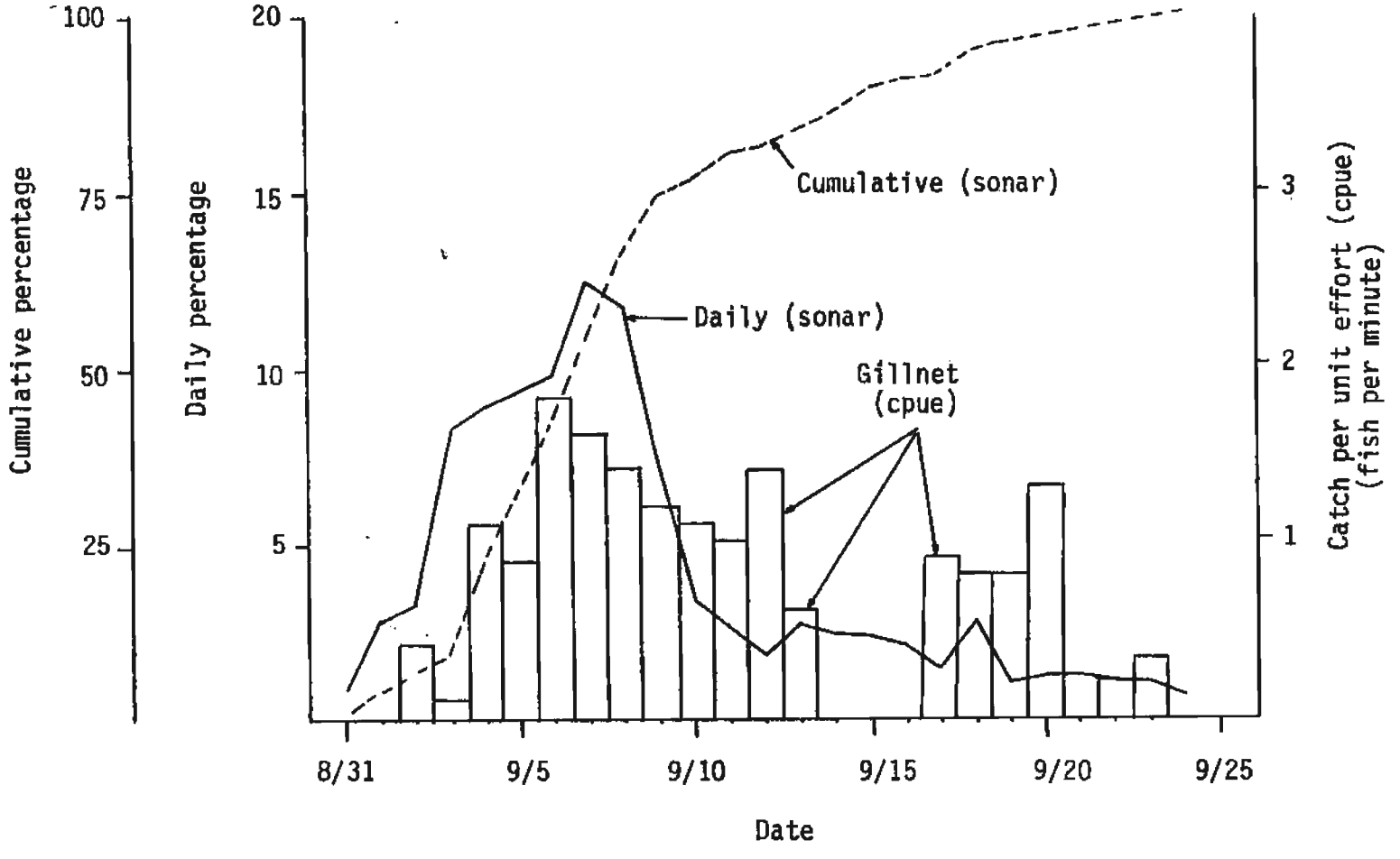

Figure 3. Relative timing of the Sheenjek River fall chum salmon escapement, based on side-scan sonar and test fishing data, 1981.

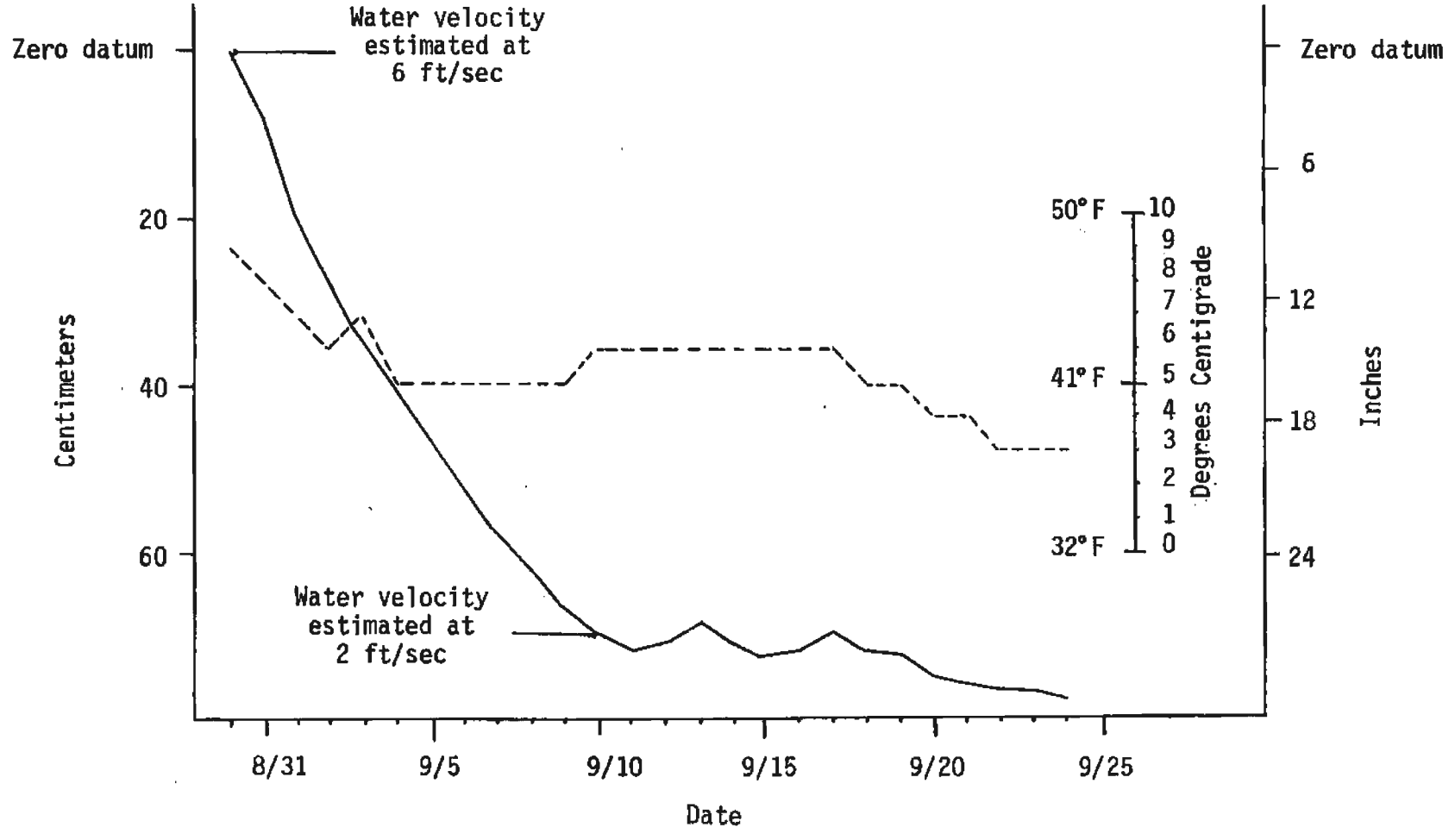

Figure 4. Daily changes in water level (solid line) and water temperature (broken line) at the Sheenjek River sonar site, August 31 through September 24, 1981.

rapidly in the early morning hours. The least amount of upstream migration appeared to occur between the hours of about 0900 and 1200.

Adult salmon milled over the sonar substrate primarily during the daylight hours. This may explain the absence of a distinct bimodal curve in Figure 5. During the peak of the run, oscilloscope calibration provided the only means available to adjust sonar counts. Consequently, data represented by Figure 5 may include an unknown percentage of false counts generated by salmon milling over the sonar substrate during the period August 31 through September 10. Milling was not the result of salmon spawning in the immediate vicinity of the sonar substrate, but rather from fish holding on or near the substrate until the onset of darkness.

Few chum salmon had reached known major spawning areas when an aerial survey was flown on September 10. Most observed spawning in previous years occurred in several spring areas, ranging from about 30 to 90 river miles upstream from the river mouth (Figure 1). Although a larger number had reached these areas by October 2, spawning was still estimated at prior-to-peak activity.

Timing of spawning in the Sheenjek River, as estimated from past aerial surveys, is shown below:

1980 - October 2 (before peak)
1979 - September 26 (at peak)
1978 - October 3 (at peak)
1977 - September 30 (at peak)
1976 - September 25 (at peak), October 19 (after peak)
1975 - September 26 (before peak), October 8 (at peak)

These data indicate that peak spawning of fall chum salmon in the Sheenjek River generally occurs sometime between the last week of September and first week of October.

The Canadian Fisheries Service operated a counting fence 1 mile below the spawning grounds on the Fishing Branch River from 1972 through 1975. Results showed arrival of fall chum salmon to first occur about September 1 and to continue through late October (Elson 1976). In the 4 years of operation, a range of 41% to 81% of the salmon escapement had been counted by September 21. Peak daily passage rates generally occurred between September 15 and 20.

Location of the counting fence was approximately 550 river miles from the mouth of the Sheenjek River. In view of the similarity in timing of chum salmon to their respective spawning areas on the Sheenjek and Fishing Branch Rivers, it is reasonable to conclude that early Porcupine River fall chum salmon are probably destined largely for the Fishing Branch River, with the latter portion of the Porcupine River fall chum salmon run bound for the Sheenjek River and possibly the Black River system.

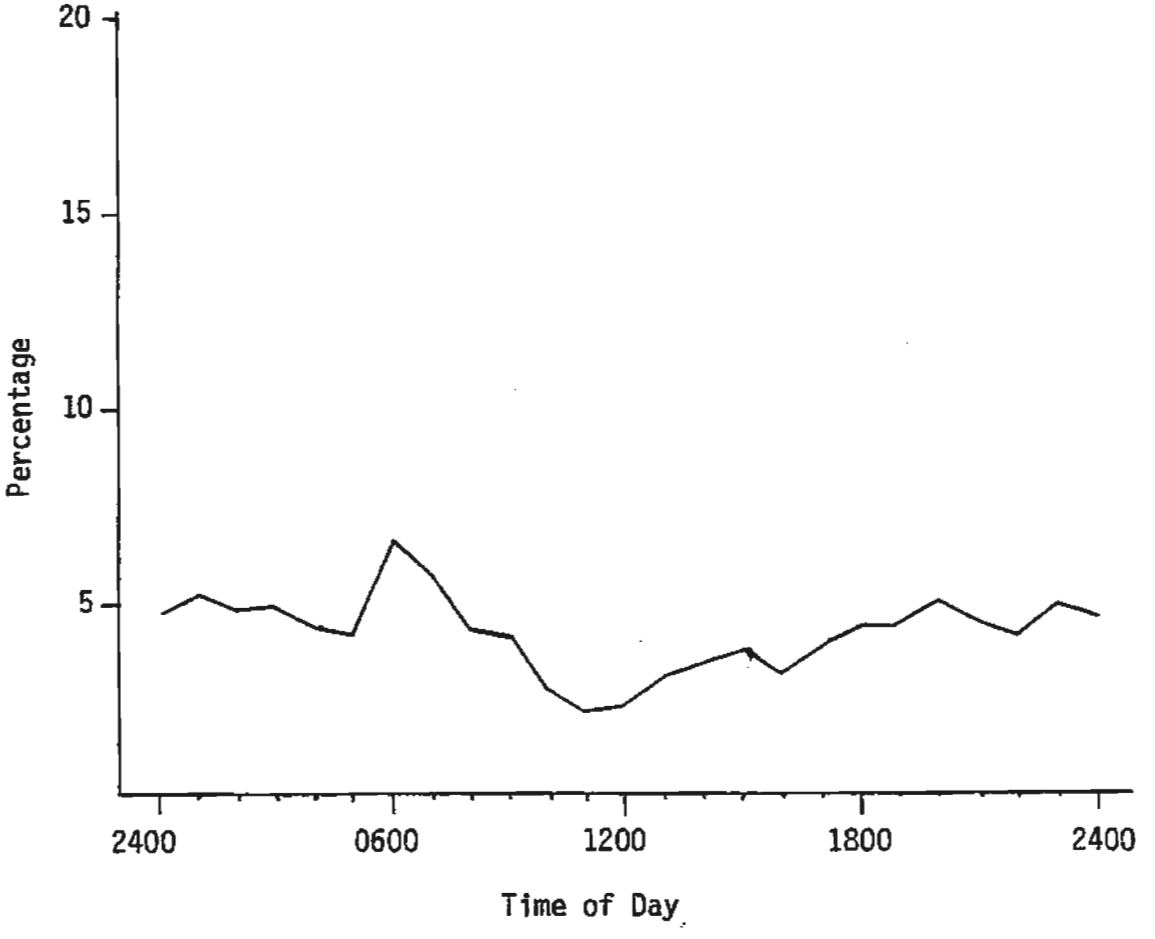

Figure 5. Distribution of chum salmon sonar counts by time of day in the Sheenjek River, August 31 through September 24, 1981.

Distribution: The distribution of upstream migrants past the 1981 sonar site appeared to be primarily confined to the west side of the river. Results revealed most adult chum salmon passed over the sonar substrate through the outer 30 ft of the counting range. More than 82% were counted in sectors 9-15 (Figure 6). Although it is known that salmon did pass beyond the counting range, the percentage is believed to be small.

It was estimated that about 35-40% of the width of the river was covered by the inshore weir and sonar counter when peak salmon passage rates occurred. It was estimated that 50% of the river was being sampled from September 10 on.

Gillnet test fishing was confined to drifting, as opposed to making stationary sets. The occurrence of log jams and underwater snags determined the actual location where drifts could be made. Consequently, it was difficult to drift with equal effort to precisely compare riverbank distribution of migrating salmon. It was concluded, however, that few adult chum salmon migrated along the east side of the river at the sonar site. A possible explanation for this may be that salmon avoid the deeper, cutbank side of the river where large snags are common and water velocities the highest. Water depth exceeded 14 ft on the cutbank side of the river on August 31 and 11 ft on September 24.

Relatively little is known concerning the distribution of spawning chum salmon within the Sheenjek River. Limited observations in past years indicate that most spawning occurs in side sloughs or old channels of the main river within the lower 100 miles of the river. Generally, it is believed that fall chum salmon spawning occurs in areas of relatively stable, upwelling ground water with winter water temperatures above 34°F (Mauney 1977). Mauney examined water temperatures over a 22-hour period at Fish Slough (mile 70) on October 29 and 30, 1975. His results are shown below.

		Fish Slough	Main Channel
October 29	1700 hrs	37°F	33°F
October 30	0930 hrs	39°F	34°F
October 30	1445 hrs	42°F	36°F

Water temperature in this important spawning area was observed to be 4° to 6°F warmer than that of the main river.

More effort is needed to accurately document spawning habitats and distribution of fall chum salmon spawners in the Sheenjek River. The extent of mainstream spawning is not known.

Abundance: Adult salmon milled over the sonar substrate throughout most of the counting period. The problem was attributed primarily to

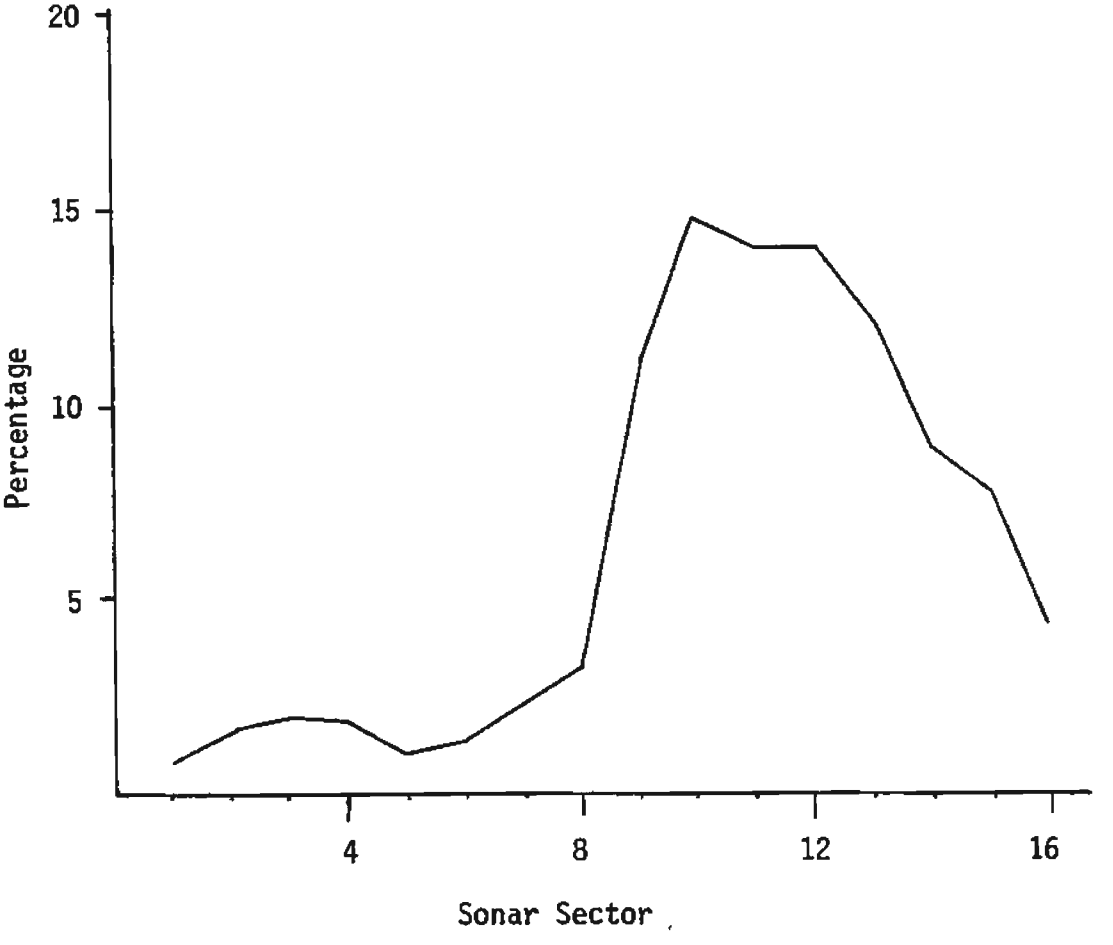

Figure 6. Distribution of chum salmon sonar counts by sector in the Sheenjek River, August 31 through September 24, 1981.

the rapid drop in water level and resulting reduced water velocities. An adjusted sonar count of 53,854 fish was recorded from August 31 through September 10, the period of greatest decline in water level (Figure 4) and velocity. The water level had fallen 27.6 inches by September 10, and water velocity was estimated at about 2 ft/sec. This time span also coincided with the poorest water clarity, hindering visual calibrations. Therefore, the adjusted count through September 10 was obtained from daily oscilloscope calibrations only; the sonar fish velocity control setting remained at 0.571 sec/ft during this period which equals a fish swimming speed of 1.75 ft/sec. A correlation of 81.3% was achieved between acoustic and oscilloscope counts at this setting.

Water clarity improved slowly with the falling water level, and by September 11 the entire substrate was visible, permitting visual calibrations from the tower. The river water level only fell another 2.8 inches from September 11 through September 24. The adjusted sonar count, using visual calibration data, for that period was 16,210 fish. Visual calibrations not only more accurately accounted for milling problems during this period but also provided corrections for percentage of downstream movement of weakened, moribund salmon during the last 5 days of operation. The fish velocity control was changed during this low and relatively slow water period, averaging 0.918 sec/ft from September 11 through September 24. This assumed a fish swimming speed of 1.09 ft/sec, and even at that setting only a 69.5% correlation between acoustic and visual counts was achieved. This setting resulted in a 71% correlation between acoustic and oscilloscope counts. (The sonar counter is designed to accurately count fish swimming at speeds of more than 1.00 ft/sec (0.999 fish velocity control setting), preventing internal compensations for slower moving fish.) These data show a difference of 1.5% between visual and oscilloscope calibrations. Consequently, the adjusted sonar count through September 10 is considered high by at least this amount. The final adjusted count for that period would be 79.8% of the raw sonar count, as opposed to 81.3%, resulting in an estimate of 52,833 chum salmon. The final estimate of chum salmon counted past the sonar site from August 31 through September 24 is 69,043.

An aerial survey of the Sheenjek River from its mouth to about 80 river miles upstream to Haystack (the local name for Outlook Mountain) was made on September 10. A total of 12,625 chum salmon was observed, of which 12,181 were located between the sonar site and Haystack. The survey estimate was low since visibility was limited to only the very shallow river areas--along gravel bars and backwater sloughs.

Chum salmon were present the entire distance surveyed. It was considered that most were still migrating to spawning areas since few were observed in known major spawning areas. Only 380 chum salmon were observed at Russell's cabin, and less than 20% of the counts were made from there upstream to Haystack, including the Fish Slough spawning area. It was quite apparent that large numbers of chum salmon migrating

up the deeper, more turbulent mainstem were not seen during this survey. Only 23% of the sonar-estimated escapement through September 10 was observed on this aerial survey.

A second aerial survey was flown of the lower 80 river miles of the Sheenjek River on October 2. A total of 12,291 chum salmon was counted, including 411 carcasses. Only 11,718 were observed above the sonar site, and spawning was again estimated at prior-to-peak activity since relatively few chum salmon were observed in the known spawning areas. This survey was also rated poor due to turbid water conditions persisting upstream of Malher's cabin. Of particular interest was the fact that very little spawning was observed in the slough at Russell's cabin. Recent rechannelization of the Sheenjek River around Russell's cabin may have resulted in destruction of spawning habitat to this important spawning area.

Less than 17% of the sonar-estimated chum salmon escapement was observed on October 2. By comparison, aerial surveys conducted on the Anvik River for summer chum salmon escapement in 1972, 1975, and 1980 have ranged from 65% to 107% of the counting tower or sonar estimates in those years (ADF&G files). The surveys were all rated fair to good. A poor survey of the Anvik River in 1973 resulted in only 15% of the estimated tower counts being observed. The Anvik River is much clearer on the average than the Sheenjek River. Consequently, past aerial surveys conducted of the Sheenjek River, which have been rated fair to good, may have only documented on the order of 50% of the actual escapement to this river.

Age, Sex, and Size Composition: A total of 429 chum salmon was gillnetted from September 2 through 23 for age, sex, and size analysis. No other species were captured. The overall male to female ratio was 1.00:0.88 or 53% males and 47% females. The slightly greater proportion of males can probably be attributed to gillnet selectivity. Males averaged 27 mm longer than females and were probably more apt to be entangled in the gillnet, due also to their enlarged upper snout and large teeth. Sex composition did not vary substantially through time.

The sample was composed predominantly of age 4_1 fish (85%), followed by age 5_1 (12%) and age 3_1 (3%) fish. Less than one-half percent was age 6_1.

The only comparative size-at-age data available from the Sheenjek River are from carcasses collected from two spawning areas in 1975--Russell's cabin area and Fish Slough (Table 3). The mean size of both males and females was substantially larger in 1981 as compared to 1975 samples. However, this difference may be partially due to gillnet selectivity. Limited data on mean size at age of fall chum salmon from the Fishing Branch River are available from 1972 (Elson 1973). Original lengths of these samples collected by the Canadian Fisheries Service were measured from tip of snout to fork of tail. The mid-eye

Table 3. Comparative age, sex, and size composition of fall chum salmon sampled at various sites in the Porcupine River drainage, 1972, 1975, and 1981.[1]

	Age 3_1				Age 4_1				Age 5_1				Total			
	n	(%)	$\bar{x}$	SD	n	(%)	$\bar{x}$	SD	n	(%)	$\bar{x}$	SD	n	(%)	$\bar{x}$	SD
Sheenjek River[2]																
1981 male	2	(0.6)	547	--	142	(41.6)	620	27.5	32	(9.4)	638	42.4	177[3]	(51.9)	623	32.5
1981 female	8	(2.3)	574	17.2	149	(43.7)	596	25.7	7	(2.1)	613	19.8	164	(48.1)	596	25.7
total	10	(2.9)	569	25.9	291	(85.3)	607	29.1	39	(11.5)	633	40.4	341	(100)	610	32.3
Sheenjek River[4]																
1975 male	2	(1.0)	599	--	79	(40.1)	599	34.2	2	(1.0)	654	--	83	(42.1)	601	34.7
1975 female	5	(2.5)	544	23.0	108	(54.8)	582	27.8	1	(0.5)	620	--	114	(57.9)	581	28.7
total	7	(3.5)	559	35.7	187	(94.9)	589	31.7	3	(1.5)	642	--	197	(100)	589	32.8
Fishing Branch River[5]																
1972 male	1	(1.7)	610	--	20	(34.5)	621	31.9	1	(1.7)	649	--	22	(37.9)	621	31.0
1972 female	4	(6.9)	561	--	29	(50.0)	598	23.2	3	(5.2)	614	--	36	(62.1)	596	26.0
total	5	(8.6)	571	29.3	49	(84.5)	607	29.0	4	(6.9)	623	--	58	(100)	605	30.5

[1] Age designated by Gilbert-Rich formula: total years of life in superscript; years of freshwater life in subscript. All lengths are mid-eye to fork-of-tail measurements.
[2] Data from samples collected with 5-7/8 inch gillnets at sonar site.
[3] Includes a single age 6_1 fish 620 mm in length.
[4] Data from carcass samples at Russell's cabin area and Fish Slough.
[5] Samples collected by Canadians at counting fence. Data modified from Elson (1973). Fish were initially measured from tip of snout to fork of tail; lengths shown here were converted to mid-eye to fork-of-tail estimates based upon fall chum salmon conversions derived from tagging studies in 1977 at Galena and Ruby (Buklis 1981).

to fork-of-tail estimates of these samples shown in Table 3 were derived from conversion factors obtained on fall chum salmon during 1977 tagging studies at Galena and Ruby (Buklis 1981). Apart from age 3_1 fish, of which only a small sample size was obtained, mean size-at-age estimates and the mean size estimate for all ages combined closely resemble the 1981 Sheenjek River samples for each sex.

Remaining data available on fall chum salmon size in the Porcupine River drainage consist of tip-of-snout to fork-of-tail measurements taken by the Canadian Fisheries Service from the subsistence catch at Old Crow in 1971 and spawning runs into the Fishing Branch from 1972 through 1975 (Table 4). Statistical data on these measurements are presented in Elson (1976). Only mean sizes were given for all ages combined for each sex. The estimated mid-eye to fork-of-tail lengths in Table 4 are also based on conversion factors presented by Buklis (1981). The predominant age composition in all of these years is suspected to have been age 4_1, based on length frequencies presented by Elson. The estimated mid-eye to fork-of-tail lengths from the upper Porcupine River samples appear to be similar to those from the Sheenjek River.

Summary

1. A sonar estimate of 69,043 chum salmon was obtained in the Sheenjek River from August 31 through September 24. Peak passage occurred on September 7.

2. Approximately 82% of the sonar counts were registered within the outer half of the sonar counting range. Although only the west side of the river was sampled by the sonar counter, test fishing results indicated the majority of chum salmon migrated up the west side.

3. Adult salmon milled over the sonar substrate throughout most of the counting period. This problem was a function of upstream migrant fish holding in or near the substrate until the onset of darkness, as opposed to actual spawning in the vicinity of the counting unit.

4. A 69.5% correlation between visual (tower) and acoustic counts was obtained. A 71% correlation between oscilloscope and acoustic counts was obtained for the same period.

5. No more than 23% and 17% of the chum salmon escapement was observed on aerial surveys flown September 10 and October 2, respectively.

6. Spawning was judged prior to peak on both the September 10 and October 2 aerial surveys when observations revealed few chum salmon present on known major spawning areas.

Table 4. Comparative size composition of fall chum salmon from the Sheenjek and Fishing Branch Rivers.

Year	Male (all ages) sample size	mean fork length (mm)	SD	estimated mid-eye fork tail length (mm)	Female (all ages) sample size	mean fork length (mm)	SD	estimated mid-eye fork tail length (mm)
Fishing Branch River [1]								
1971	275	639.0	31.8	574	48	609.6	34.5	561
1972	226	691.3	33.5	621	435	643.3	28.2	592
1973	272	685.3	37.5	616	345	638.9	31.8	588
1974	62	634.6	53.8	571	57	598.9	46.3	551
1975	151	680.5	36.5	612	151	634.3	25.6	584
Sheenjek River [2]								
1975 [3]	83	--	34.7	601	114	--	28.7	581
1981 [4]	177	--	32.5	623	164	--	25.7	596

[1] Data modified from Elson (1976). Initial measurements were from tip of snout to fork of tail; estimated mid-eye to fork-of-tail lengths are based upon fall chum salmon conversions derived from 1977 tagging studies at Galena and Ruby (Buklis 1981). The 1971 sample was taken at Old Crow.
[2] All samples measured from mid-eye to fork of tail.
[3] Data from carcass samples collected from Russell's cabin area and Fish Slough.
[4] Data from samples collected with 5-7/8 inch gillnets at sonar site.

7. The male-to-female chum salmon ratio was 1.00:0.88 (53% males, 47% females) based on gillnet samples collected from September 2-23.

8. The Sheenjek River chum salmon escapement was predominantly age 4_1 fish (85%), followed in order by age 5_1 (12%) and age 3_1 (3%) fish. Only a single age 6_1 fish was included in the samples.

Conclusions

1. It can be said with certainty that the Sheenjek River fall chum salmon escapement exceeded 29,000 in 1981. This is based on: a) the low aerial survey count (12,181) of September 10; b) visually calibrated sonar counts (16,210) from September 11 through September 24; c) the realization that some chum salmon were already present in the Sheenjek River above the sonar site by August 31; and d) the fact that 571 chum salmon were observed below the sonar site on October 2. Although some error may exist in the adjusted sonar count of 69,043 due to salmon milling problems, it is probable that the fall chum salmon escapement approached 70,000 in 1981. An unknown but probably low percentage of the migrating salmon also passed upriver beyond the counting range of the sonar unit.

2. Although the fall chum salmon run to the Sheenjek River commenced prior to August 31 and continued beyond September 24, it is highly probable that the greatest proportion of the run was enumerated during the sonar feasibility study and that timing of peak abundance was accurately documented in 1981.

3. Overcounting by the sonar counter was attributed, at least in part, to three conditions: a) slow water velocities associated with falling water level; b) location of the substrate in relation to water velocities; and c) inability to adjust the sonar counter to compensate for fish swim speeds of less than 1 ft/sec. In spite of these problems, it was considered that site location was conducive to the side-scanning sonar system and that sonar can be effectively used to monitor fall chum salmon escapements in the Sheenjek River at the 1981 location. It is further concluded that the milling problems encountered in 1981 can be greatly reduced by positioning the substrate farther out from the west bank, where faster water velocities would deter adult salmon from milling in the counting area. A larger (longer) weir could be constructed at the existing site. A second sonar counter could be deployed from the east bank (depending on water levels) about 200 yards downstream from the existing west-bank counter, if a substantial number of chum salmon are found to be avoiding the west-bank counting area.

Recommendations

In view of the lack of data on Yukon River fall chum salmon, particularly in the Porcupine River drainage, it is recommended that side-scanning sonar be used to monitor Sheenjek River escapements. Sonar counting should be accompanied by a viewing platform for calibration purposes and should commence prior to September, if possible.

The 1981 commercial harvest of Yukon River fall chum salmon was the highest on record, and the performance of the fishery indicated a very large fall chum salmon return. It was anticipated that large, and perhaps even record, escapement levels to many index streams would be observed during aerial surveys. No more than 12,625 chum salmon were observed from the air in the Sheenjek River this past season, whereas sonar resulted in an estimate of approximately 69,000 fish. The value of sonar is evident.

Further, a field site location on the Sheenjek River provides an excellent opportunity to expand the data base on fall chum salmon stream life history. It is recommended that tagging be conducted at the sonar site and spawning ground tag-recovery surveys be conducted later to examine spawner residence time, spawning distribution, and physical requirements by spawners. Access to the spawning grounds can be provided by riverboat or aircraft.

It is recommended that, if the side-scanning sonar is to be used on the Sheenjek River, a modification be made to the counter to allow for adjustments for fish swim speeds of less than 1 ft/sec. Modification is plausible since it can be expected that river water levels, and in turn velocities, will lower during the time of year fall chum salmon ascend tributaries to spawn. This differs from conditions expected during the earlier spawning seasons for summer chums and other salmon species throughout the Yukon River drainage, i.e., rising water levels and faster water velocities from spring snow melt and summer rain runoff. These spring conditions often result in debris-laden water which may hinder accurate sonar counting.

In the future, daily water velocities should be estimated at the sonar site to serve as an indicator of necessary changes in the fish velocity control setting on the side-scan sonar unit.

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